INFORMATION TECHNOLOGIES

IMAGES COMPRESSION BY USING CUBIC SPLINE-FUNCTIONS METHODS

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The object of research is image compression algorithms based on mathematical methods. The main problem with image compression is loss of quality during recovery. The approach is proposed in which the user can determine the quality of the reconstructed image itself. This is achieved due to the use of the spline interpolation method, which allows to set the compression ratio, thus controlling the quality of the decoded image.

The use of the spline function for image compression makes it possible to reduce the processing time of files due to the simplicity of the mathematical model of the algorithm. Given the accuracy of the restored image, the algorithm determines the size of the compressed file, depending on the color scale.

As a result of the analysis of the proposed development, the compression coefficients are shown, which show that the size of the compressed image can be smaller than the original image by 50–70 %. The decoding is performed using known spline function coefficients. The result is compared with the original file. The difference between the intensity of the points of the source and decoded images determines the quality of the restoration.

An algorithm is obtained that allows one to specify the accuracy of the reconstructed image. This result depends on the weighting coefficients of the spline function, which affect the accuracy of the construction of the approximating polynomial. A feature of the proposed approach is the ability of the user to specify the accuracy and quality of the image after decoding. This is achieved due to the fact that points close in intensity value are restored with a small error.

In this paper, let's propose an approach involving the sequential extraction of blocks of points of equal intensity. For the selected blocks, an approximating polynomial is constructed based on the spline function, and the coefficients of the polynomial are transferred to a file containing information for image reconstruction. So it is possible to obtain large compression ratios by building a polynomial for blocks containing points that are close in intensity.

Keywords: images coding, compression images, raster images, coefficients of the spline function, approximating polynomial.

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THE EMERGENCY SIMULATION WITH THE HELP OF FOUR-LAYER HIDDEN MARKOV MODEL

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The object of research is the process of selecting a synergistically determined pair for the elements of complex systems in the design, manufacture or repair. One of the most problematic places in the selection is the need to numerically evaluate the result of combining the elements, taking into account the explicit, additive properties of elements and hidden manifestations of the pair that are unusual for the elements alone (emergence). Lack of accounting for emergence can significantly distort the apparent picture of the processes taking place in systems, which makes many existing models of such processes inadequate.

During the research, methods of extracting information from arrays known, hidden for direct observation were used. In parti-

cular, four-layer hidden Markov models with an additional hidden layer were used. The models were trained by the Baum-Welch method, adapted to work with an additional layer. As training samples used data obtained as a result of statistical processing of information available for object monitoring, expert assessments, as well as data obtained in the world's computer networks.

The test of the method and model on real medical and technical objects confirms their clinical and technical effectiveness. In particular, thanks to this in the medical industry:

– in the medical industry, the incidence of thromboembolism of the branches of the pulmonary artery and deep veins of the thigh and lower leg are decreased by 65 %;

– frequency of postoperative bleeding is decreased by 43 %;

– by 36 % the total number of drug-related medicines aimed at correcting the blood coagulation system is decreased.

In the technical field, the test results confirm the increase in the service life of rubber-metal shock absorbers by 14.5 %.

This is due to the fact that the proposed method has a number of features, in particular, for the first time in its evaluation of emergence a four-layer hidden Markov model is used.

The results obtained in the work make it possible to propose a general scheme of an intellectual decision support system in the selection of a synergistically determined pair of elements for complex systems of various purposes.

Keywords: synergetic effect, accounting for emergence, hidden Markov model, hidden layer, adequacy of the model.

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SYSTEMS AND CONTROL PROCESSES

ANALYSIS OF E-DOCUMENT MANAGEMENT SYSTEMS IN UKRAINE AND CRITERIA FOR THEIR SELECTION

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The object of research is the criteria for selecting the e-document management system (EDMS) in the IT market of Ukraine and the life cycle of the management decision in the EDMS. One of the most problematic places is the lack of systematic

research on the state and peculiarities of the implementation of document management automation systems in Ukraine. Data on market volumes and development prospects are approximate and are determined on the basis of the assessments of the market participants themselves. In such circumstances, the choice of software for e-document management is becoming a challenge. The modern process approach in EDMS obliges the customer to clearly represent the essence of automation processes. A significant factor affecting the success of e-document implementation projects is the need to formalize the basic processes.

In the process of research, the following methods were used: bibliographic, monographic, comparative and synthetically analytical, method of logical generalization and systematization, algorithmic with graphical representation of the results.

The complex analysis of the features of the introduction and actual trends in the development of the world and Ukrainian e-document management systems was conducted. Taking into account these features and trends, a system of effective evaluation criteria for software for the automation of Ukrainian document management has been developed. The criteria are divided into groups corresponding to the stages of the life cycle of the automated system and the requirements of the modern IT market.

The developed system of criteria allows the enterprise-customer to carry out the optimal choice of software for introduction of e-document circulation on the set of those criteria that satisfy its automation tasks.

The detailed description of the formalized algorithm of the life cycle of the management solution in e-document management systems of Ukraine is given. Thanks to the use of such algorithms, at the start of the implementation projects, the customer enterprise provides a clear understanding of the essence of the automation processes, which, accordingly, reduces the risks of the project.

Keywords: e-document management systems, management of information resource, process management, selection criteria.

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DEVELOPMENT OF METHODICAL APPROACH TO THE ANALYSIS OF INTEGRATION RISKS IN THE PROJECT OF CREATION OF THE LOGISTICS CENTER

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The object of the research is the project of a logistics center, which is considered as an organizational and production integrated complex system, the main task of which is provision of the conditions for the integration of various objects of logistical and related infrastructure in one territory. This provides an opportunity to improve the movement of logistic flows.

One of the most problematic places is the lack of a project-oriented approach in the creation of a logistics center, which is characterized by a large number of participants, changing throughout its life cycle. This leads to the emergence of integration project risks, for the prevention of which it is necessary to develop an approach to qualitative risk analysis that takes into account the specific features of the research object.

In the course of the study, the concept of «integration project risk» is defined and a sequence of qualitative analysis of integration risks in the project of creating a logistics center is also developed, which consists of using quality management methods, namely: Pareto analysis, ABC analysis and Ishikawa cause-and-effect analysis. The application of methods of qualitative analysis is carried out in a logical sequence. The output data obtained from the previous analysis is the input for the next stage of the study.

The obtained results of a qualitative risk analysis allow at the initial stage of the project to increase the impact on its results by

reducing the degree of integration risks. In particular, the Pareto analysis is proposed to be used to identify the main reasons for the emergence of integration risks for the project of creating a logistics center. ABC-analysis allows to identify project participants who have the greatest number of integration ties. Therefore, the withdrawal of such a participant from the project will bring the greatest violations of integration between the elements of the system. The Ishikawa cause-and-effect analysis makes it possible to identify the causes of the disruption of integration ties between the project participants and to determine the least powerful integration ties between the participants.

Consequently, using of the proposed sequence of qualitative analysis will identify the project participants who are most vulnerable to the impact of integration risks and determine the power of integration ties between them. This, in turn, will allow taking measures to prevent the approaching of integration risks in the project of creating a logistics center.

Keywords: project of creating a logistics center, integration risks, qualitative analysis of project risks.

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DEVELOPMENT OF THE METHOD OF AUTOMATIC DETERMINATION OF THE SPEAKER GENDER ON THE BASIS OF JOINT EVALUATION OF FREQUENCY MOMENTS OF BASIC TONS AND FORMANT FREQUENCIES

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The object of research is the methods of recognizing the speaker gender by means of speech signals. One of the most problematic places is insufficient knowledge of the choice of signs and decisive rules. This is necessary to increase the probability of correct recognition and noise immunity of gender recognition by voice signals in conditions of interference. It is also important to simplify the implementation of algorithms for recognizing the speaker gender.

For recognition of the speaker gender, a new set of classification characteristics is selected, including the joint use of estimates of the average value of the pitch frequency, its kurtosis coefficient, estimates of the mean values of the formants and their asymmetry coefficients. In the course of the research, the method of statistical testing of the proposed algorithms on a personal computer is used. The experiments are carried out using real audio signals input from a microphone into a personal computer for both female and male representatives, and recorded as separate files. For this purpose, 10 standards of 10 words are used for each of the 5 female speakers and 5 male speakers.

Based on the results of statistical tests for an algorithm involving the joint use of estimates of the mean value of the pitch frequency, its kurtosis coefficient, estimates of the mean values of the formants and their asymmetry coefficients, an average probability of correct recognition is obtained 1. With the additional action of additive noise of the Gaussian type, white noise and the ratio of the signal/noise $q=20$, for such algorithm the probability

of correct recognition is experimentally obtained – 0.8. For the decision algorithm, which uses only estimates of the average value of the pitch frequency and its kurtosis coefficient, an average probability of correct recognition is estimated at 0.9. This indicates more noise immunity of such algorithms.

In the future, the use of the obtained results not only for Russian and Ukrainian languages, but also for a number of foreign languages is supposed.

Keywords: speaker gender recognition, formant-band signs, asymmetry coefficient, pitch frequency.

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DIGITAL COMPETENCIES ANALYSIS AS VECTOR OF HIGHER SCHOOL REFORMING

page 34–39

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The object of research is digital literacy. There are many methods for assessing the level of digital literacy in society. Particular attention is paid to the conceptual model of the formation and evaluation of the level of digital literacy, which involves identifying all areas of knowledge, skills and connections that should be considered for development of digital competence.

One of the most problematic places is that full-scale implementation of digital competences, in accordance with the conceptual model, is significantly complicated in modern Ukrainian society. The structure of digital competencies for specialists from different fields is not harmonized, it does not take into account the special professional needs, which should focus on the formation of curricula and training materials designed to form the appropriate digital skills. The educational reform that is taking place in Ukraine is fundamentally changing approaches, methods and learning technologies. At the same time, decisive changes in the direction of digitization of education and the provision of skills to the relevant digital competences to different groups of the population can only be achieved if the state supports educational reforms. International standards for measuring global computer literacy in Ukraine are only beginning to be used, which does not allow Ukrainian citizens to fully realize their potential.

During the research, the necessity of harmonious introduction of digital technologies in the educational process of universities was substantiated, the principles of Ukraine's development in the digital community and the basis for the development of its digital economy were determined. The article proposes an author's model for measuring the digital competence of students, which is the evolution of a pyramid model of digital literacy. This model links the components of digital literacy with the development processes from the general methods of using digital competences to the improvement of the digital skills needed by specialists of certain branches. It is very important that this model focuses on the need to change the digital competences depending on the context of professional activity.

Keywords: digital competences, postindustrial education, information society, digital literacy, media literacy, information literacy.

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DEVELOPMENT OF METHOD OF INCREASING THE PERFORMANCE OF TOUCH NETWORKS OF MEASUREMENT OF DISTANCES

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The subject of the study is the wireless sensor network of the ZigBee protocol, which in this study is proposed for performing the function of measuring the distance between objects. The main areas of application are security facilities, such as warehouses, shops, exhibitions and expositions, where it is important to control the movement of valuables in a limited area with a large concentration of people. The sensors are made on a flexible basis, attach to valuable objects and all the time transfer information about the distance relative to each other. One of the most problematic places is the limited bandwidth of data transmission channels. Also, for the above-described rooms are all kinds of obstacles, like mechanical (walls, partitions, metal shelves), and radio interference, for example, wireless network interfaces of buyers' phones and others.

The study used a method to improve the performance of wireless sensor networks within computerized distance measurement systems based on the decomposition of the lower levels of the OSI reference model.

The same capacity indicators as for analogues were obtained, but the load that the network node sustained was 2.5 times higher. This is due to the fact that the proposed method of increasing productivity, has a number of features that improve performance characteristics, in particular in areas of uncertain reception almost twice.

Thanks to this, it is possible to operate the network at a maximum speed of 32.5 Mbps. Compared to analogs in which the maximum speed is 12.5 Mbps this provides more accurate results of distance measurement. Also, thanks to this speed reserve, the best noise immunity is provided, as well as the ability to locate network nodes at distances that are greater than those of analogues.

Keywords: wireless network, mechanical quantities, computerized measurement system, information-measuring system.

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DEVELOPMENT OF SOFTWARE-BASED ROUTER MODEL WITH ADAPTIVE SELECTION OF ALGORITHMS FOR QUEUES SERVICING

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The object of the research is the processes of managing resources of queues in network devices of telecommunication networks.

The one of most problem places is ineffective management of queues in network devices that results in worsening the servicing quality. They are based mainly on decentralized algorithms of managing resources, realized on separate nodes of networks. The other important disadvantage is realization of the static hand strategy of allocation of channel resources, which managing process is not always adequate to the profile of input traffic. At the same time solutions, received on separate network nodes in concrete time moments, are not coordinated in the process.

For eliminating the aforesaid shortcomings, there is offered to use the improved method of servicing queues in network devices, one of key differences of the offered method is in the control over the time packets' being in queues. And under conditions of exceeding the permissible time of waiting, a packet is transmitted on a queue with a lower priority and first-turn servicing. It gives a possibility to improve the effectiveness of allocation of network resources by the criterion of servicing quality.

For realizing this approach, there was developed the software-based router model that, as opposite to known ones, has a module structure and gives a possibility to reproduce the work of a telecommunication network of any configuration in the real-time mode. It is provided to use the router prototype for adaptive servicing the load of the main level. Comparing to analogous systems, created, based on CISCO equipment, the aforesaid model provides competitive advantages at the guaranteed quality of

servicing the determined real-time streams with the synchronous decrease of cost and complication of their setting. Under conditions of the additional productivity of hardware of the router prototype, the offered model is realized by the developed software. It provides an advantage by the efficiency of delivering correspondent real-time stream, namely decrease of delays at their processing reaches 40 %, jitter decrease – 35 %.

Keywords: multiservice network, quality of service, resource allocation, software-based router model.

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MATHEMATICAL MODELING

OPTIMIZATION OF THE ACYCLIC ADDERS OF BINARY CODES

page 55–65

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The object of research is a prefix model for calculating adding and transport signals in a parallel adder circuit with a parallel transfer method. One of the most problematic places in the prefix model is the process of generating adding and carry signals, in which the beginning of the prefix calculation is provided from the first bit of the circuit. This leads, in the end, to excessive accumulation and complications of the hardware part of the device.

In the course of the research, a mathematical model is used to calculate the adding and carry signals in a parallel adder circuit based on the properties of a directed acyclic graph with two typical operations.

The complexity of the logical structure of the adder of binary codes is reduced, the depth of the circuit is reduced and the total length of the connecting wires is reduced. This is due to the fact that the proposed method for calculating adding and transport signals has a number of features of the device circuit synthesis, in particular, the application of a mathematical model based on the properties of an acyclic graph is calculated for:

– process of sequential (for lower order devices) and parallel calculation of adding and carry signals, which, in the end, reduces the complexity of the hardware of the device and does not increase the depth of the circuit;

– comparison of the number of computational steps of an oriented acyclic graph with the number of transfers of one to the high-order bit in the adder circuit, which allows to determine the optimal number of computational steps for the structure of the device.

Due to this, it is possible to obtain optimal values for the complexity of the structure and the depth of the adder circuit. The connection between the number of computational steps of an oriented acyclic graph and the number of transfers in the parallel adder circuit with a parallel transport method indicates the expediency of comparing the structure of the adder with the corresponding oriented acyclic graph.

In comparison with similar known structures of 8-bit prefix adders, this provides an increase in the quality index of 8-bit acyclic adders, for example, by power consumption, the chip area, depending on the chosen structure, by 10–40 %.

Keywords: acyclic model, prefix model, directed acyclic graph, Ling Adder, Kogge-Stone Adder, Brent-Kung Adder.

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APPLICATION OF THE TECHNIQUE FOR AGGREGATING THE ELEMENTS IN A FORMALIZED GEOMETRIC MODELING OF MULTIFACTOR PROCESSES IN GEOMETRIC ECONOMETRICS

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The object of the study is the modeling of multifactor systems in the sphere of geometric econometrics. Modeling of economic, ecological and any other processes that occur at real objects of management has its own peculiarities. In particular, its goal is to provide the basis for making the optimal management decision in the field of activity that is modeled. Currently, a wide range of methods and models have been developed.

One of the most problematic places is the need to take into consideration a large number of initial information of a different physical nature. This greatly complicates the model. Adequate models are complex, have limitations on the number of factors, and are not universal. Simpler universal models are rather

approximate, with low adequacy. These shortcomings are eliminated in the method of creating universal models, proposed in the formalized geometric modeling of multifactor processes. This method should be able to take into consideration any finite set of factors, the quantity and quality of which could be changed without restructuring, in this case, the model itself.

In the course of research, the mathematical apparatus of Balyuba-Naidysh point calculation was used. That made it possible to conveniently formalize any number of outcomes of factors of different physical nature. On its basis, a sequence of constructing a geometric model using point aggregates has been developed, as well as its advantages and disadvantages. The basis of the developed method is the use of the properties of the simple ratio of three points of the line in Balyuba-Naidysh point calculation.

Owing to this, it became possible to split a complex multifactor problem into an appropriate number of simple one-factor problems, which greatly simplifies the calculations.

Thus, a method for creating universal geometric models using the Balyuba-Naidysh point calculation is proposed. It opens up new possibilities for modeling and studying multifactor systems, in comparison with similar known modeling methods. The method is universal, takes into consideration any necessary number of factors of any nature. It also makes it possible, with changing factors, to conveniently reconfigure the model without changing the model itself.

Keywords: formalized geometric modeling, aggregation of elements, Balyuba-Naidysh point calculation, parametric connection, point aggregate.

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